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## THE MOTION OF THE SOLAR SYSTEM IN SPACE [BY OSCAR STUMPE].

The *Astronomische Nachrichten* nos. 2999–3000 contains a very thorough investigation of the motion of the solar system in space, of which a brief analysis will be given here. The principle at the bottom of this investigation is that first worked out by Sir WILLIAM HERSCHEL and depends on the fact that the stars which lie in the region *towards* which the solar system is moving will, on the whole, seem to separate from each other, while the stars in the region *from* which the system is moving will, on the whole, seem to crowd together, while, again, the stars on the two sides, as it were, will, on the whole, keep their relative distances. The case is analogous to that of a traveller moving in a straight path through a forest of trees. Those in front of him will seem to separate and those behind will seem to crowd together, owing to appearances caused by his own motion. The trees in a forest are fixed and all the apparent motions are apparent only—parallactic—caused by the movement of the traveller. Each star, however, has a motion of its own—*motus peculiaris*—as well as a motion due to the displacement of the observer—*motus parallacticus.*

The first step, then, in an investigation of the sort, is to obtain determinations of the observed stellar motions which are as precise as possible. As the total motion of a star in a hundred years even, is itself a small quantity, it is of the first importance to determine this datum with accuracy. Dr. STUMPE has chosen for consideration all stars whose proper motion in a century is as great as 16″. There are 1054 such stars whose positions and proper motions for 1855.0 are given, after having been reduced to the system of NEWCOMB (Washington observations 1870) and BOSS (Declination of Fixed Stars 1877).[*] Unfortunately they are not regularly distributed over the sky and the great majority of them are northern stars. With these materials, the author proceeds to the solution of the problem. Almost all preceding investigations of the sort, of which there have been many, have been carried on under the assumption that the

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[*] Professor BOSS pointed out to me in a private letter (which I have his permission to use) that Dr. STUMPE has erroneously assumed that the systems of AUWERS and NEWCOMB-BOSS are practically identical for 1755. The difference NEWCOMB — AUWERS has been treated by FARQUHAR in the *Astronomical* JOURNAL No. 209 (see also A. J. No. 213) and the difference BOSS — AUWERS in A. J. 196 (see also *Proc.* A. A. A. S. 1879 ) It appears that the correction for the Zodiacal Stars necessary to reduce the Fundamental Catalogue of AUWERS to the system of the American Ephemeris is

For R. A. $+ 0^{s}.006 + 0s.0008\ (T - 1875)$, and
For Decl. $+ 0''.22 - 0''.013\ (T - 1875)$ approximately.

The Decl. correction varies, however, quite markedly from north to south.

*motus peculiaris* of each star was subject to no law, but might equally probably be directed to any point of the sky. If, however, we do not regard the aggregation of the stars in the Milky Way as a merely accidental circumstance, it is logical to suppose that the true motion of a star must stand in some relation to the plane in which the Milky Way lies. This consideration led Sir JOHN HERSCHEL to the hypothesis of a Rotation of the stellar system in the plane of the Milky Way, according to which each star was supposed, in general, to revolve in a somewhat eccentric orbit about the centre of the Milky Way, this orbit being only slightly inclined to its plane. The author has included in his equations (which are in the form first proposed by Professor SCHOENFELD) terms which express such a rotation, as well as the usual terms which express the corrections to the precession constants and the terms which express the Sun's motion in space. The same form of equations has previously been adopted by Dr. BOLTE and by Dr. L. STRUVE. In order to take the next step it would be convenient to make some hypothesis as to the relative distances of the different classes of stars used in the discussion. In Dr. STRUVE's memoir he has supposed the stars used to be situated at certain relative distances from the Sun depending directly on their magnitudes; Dr. BOLTE has divided the stars used by him into three classes according to their magnitudes, namely: 1st, 5.5 to 7.4 mags.; 2d, 7.5–8.2 mags.; 3d, 8.3–10 mags., and has solved the equations for each class separately, thus determining, from the data, the relative average distances of each of his classes. (Dr. BOLTE's results did not, however, show a certain law of increase of distance with increase of faintness.) Dr. STUMPE has chosen another method of estimating the distance of the stars of his list, that is, he has divided them into four classes according to the magnitude of the observed proper motions, thus:

Class I contains 551 stars whose proper motions are between 16″ and 32″ in a century.

Class II contains 340 stars whose proper motions are between 32″ and 64″ in a century.

Class III contains 105 stars whose proper motions are between 64″ and 128″ in a century.

Class IV contains 58 stars whose proper motions are over 128″ in a century.

These data lead to 2108 equations containing 5 unknown quantities, which are to be solved by least squares. Dr. BOLTE and Dr.

STRUVE, in their investigations, made use of certain simplifications which materially reduced the enormous labor of the solution, but, as it is by no means sure that such simplifications did not somewhat influence their final results, Dr. STUMPE has valiantly rejected all simplifications, and has solved these equations just as they stand. This labor is not lost, for it gives his investigation a high authority, since his results are the pure outcome of observed facts, free from all hypothesis.

The solution of the equations shows no sign of any systematic rotation of the stars about the Milky Way. Dr. STUMPE points out that this result may not be due to the absence of such a general rotation, but that it may simply be caused by the fact that most of the stars of his list are northern stars. When the stars of the southern sky have been as completely investigated as those of the northern hemisphere, this work should be repeated in the same thorough manner. Leaving, then, the question of a general rotation of the stars and solving the equations for the Right-Ascension and Declination of the point towards which the Solar System is moving (R. A.; Decl.), and for the velocity of the sun's motion as seen from each group of stars $\left(\frac{c}{\rho}\right)$, Dr. STUMPE obtains—

| Class | R. A. | Decl. | $\left(\frac{c}{\rho}\right)$ | Mean Magnitude of each Group. | Mean Proper Motion of each Group. |
|---|---|---|---|---|---|
| | ° | ° | ″ | | ″ |
| I | 287.4 | + 42.0 | 0.140 | 6.0 | 0.23 |
| II | 279.7 | + 40.5 | 0.295 | 6.7 | 0.43 |
| III | 287.9 | + 32.1 | 0.608 | 6.1 | 0.85 |
| IV | 285.2 | + 30.4 | 2.057 | 6.5 | 2.39 |

The comparison of the column $\left(\frac{c}{\rho}\right)$ with the last column shows not only that the stars with large proper motion are nearer to us than the rest, but the numbers agree well with the hypothesis that the distance of a star is inversely proportional to its proper motion. There is no relation between the magnitudes and the distances of the stars used in the investigation.

The foregoing abstract gives the main results of Dr. STUMPE'S work, but it fails to do justice to the thoroughness and rigorously scientific spirit of the plan of investigation. The final figures set down in the last table would have the highest authority, if the systematic corrections of the original star-places were revised and the work repeated. E. S. H.

### ADDENDUM TO LUDLAM'S ASTRONOMICAL OBSERVATIONS (1769).

In 1769, the Reverend W. LUDLAM printed a volume, whose title-page is as follows:

> Astronomical observations made in St. John's College, Cambridge, in the years 1767 and 1768, with an account of several astronomical instruments, by the Reverend Mr. LUDLAM. Printed by J. ARCHDEACON, printer to the University, for T. CADELL, successor to Mr. MILLER, in the Strand, London, MDCCLXIX.

The copy of this work in the library of the U. S. Military Academy at West Point, which I used in the years 1871–2, is full of manuscript corrections, and it contains also a manuscript note, in which the Reverend author sets forth his grievances. I have thought that this should not be unknown, and I copy it below, with the reminder that a considerable part of the income of the Universities of Oxford and Cambridge was and still is derived from their exclusive privilege of printing the Authorized Version of the Bible. E. S. H.

### *MANUSCRIPT NOTE BY THE AUTHOR.*

"*The university printer being very ignorant, and the press meanly* "*provided with types for books of science, there are many inaccuracies* "*in the printing of this book; some of which are corrected with the* "*pen.*

" *The gainful monopoly of printing bibles and common prayer* "*books, is the only object that engages the attention of the University* "*officers and their greedy printer.* *W. L.*"

### THOLLON'S MAP OF THE SOLAR SPECTRUM.

The third volume of the *Annals of the Observatory of Nice* is accompanied by a magnificent folio-atlas, containing a map of the solar spectrum. This atlas is the fruit of some six or seven years' work by M. THOLLON; and, after his death, M. PERROTIN, the Director of the observatory of Nice, employed parts of three or more years in completing it for publication. It is not possible to give in this place an adequate review of this great work. An excellent short